SH Gosford Residential Pty Ltd

Acid Sulfate Soils Management Plan 26-30 Mann Street, Gosford NSW

Purpose:

To provide an acid sulfate soils management plan for the treatment and disposal of potential acid sulfate soils at the site.

Prepared for:

Frank Katsanevas

Document Date:

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Reference:

S-02188.ASSMP.001 V3

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DOCUMENT CONTROL

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Sign Off:		
Author:	Reviewer:	Approver:
		
Kim Femia	Ryan Jacka	Ryan Jacka
Senior Consultant	Principal Consultant	Principal Consultant

STATEMENT OF LIMITATIONS

This document has been prepared in response to specific instructions from the client to whom the report has been addressed. The work has been undertaken with the usual care and thoroughness of the consulting profession. The work is based on generally accepted standards, practices of the time the work was undertaken. No other warranty, expressed or implied, is made as to the professional advice included in this report.

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Sampling Risks

EDP acknowledges that any scientifically designed sampling program cannot guarantee all subsurface contamination will be detected. Sampling programs are designed based on known or suspected site conditions and the extent and nature of the sampling and analytical programs will be designed to achieve a level of confidence in the detection of known or suspected subsurface contamination. The sampling and analytical programs adopted will be those that maximises the probability of identifying contaminants. The client must therefore accept a level of risk associated with the possible failure to detect certain subsurface contamination where the sampling and analytical program misses such contamination. EDP will detail the nature and extent of the sampling and analytical program used in the investigation in the investigation report provided.

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Soil contamination can be expected to be non-homogeneous across the stratified soils where present on site, and the concentrations of contaminants may vary significantly within areas where contamination has occurred. In addition, the migration of contaminants through groundwater and soils may follow preferential pathways, such as areas of higher permeability, which may not be intersected by sampling events. Subsurface conditions including contaminant concentrations can also change over time. For this reason, the results should be regarded as representative only.

The client recognises that sampling of subsurface conditions may result in some cross contamination. All care will be taken and the industry standards used to minimise the risk of such cross contamination occurring, however, the client recognises this risk and waives any claims against EDP and agrees to defend, indemnify and hold EDP harmless from any claims or liability for injury or loss which may arise as a result of alleged cross contamination caused by sampling.

Reliance on Information Provided by Others

EDP notes that where information has been provided by other parties in order for the works to be undertaken, EDP cannot guarantee the accuracy or completeness of this information the client therefore waives any claim against the company and agrees to indemnify EDP for any loss, claim or liability arising from inaccuracies or omissions in information provided to EDP by third parties. No indications were found during our investigations that information contained in this report, as provided to EDP, is false.

Recommendations for Further Study

The industry recognised methods used in undertaking the works may dictate a staged approach to specific investigations. The findings therefore of this report may represent preliminary findings in accordance with these industry recognised methodologies. In accordance with these methodologies, recommendations contained in this report may include a need for further investigation or analytical analysis. The decision to accept these recommendations and incur additional costs in doing so will be at the sole discretion of the client and EDP recognises that that the client will consider their specific needs and the business risks involved. EDP does not accept any liability for losses incurred as a result of the client not accepting the recommendations made within this report.

CONTENTS

GLOSSARY OF TERMS

Abbreviation:	Definition:
ASS	Acid Sulfate Soils (including Actual Acid Sulfate Soils and Potential Acid Sulfate Soils)
AASS	Actual Acid Sulfate Soil
ASSMAC	Acid Sulfate Soil Management Advisory Committee
ASSMP	Acid Sulfate Soil Management Plan
EPA	Environment Protection Authority
NATA	National Association of Testing Authorities
PASS	Potential Acid Sulfate Soils
pHf	Field pH with the addition of deionised water onsite
pHfox	Oxidised pH with the addition of peroxide onsite
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfate

1. INTRODUCTION

SH Gosford Residential Pty Ltd (St Hilliers) engaged EDP Consultants Pty Ltd (EDP) to prepare an Acid Sulfate Soils Management Plan (ASSMP) for the vacant lot located at 26-30 Mann Street, Gosford NSW (the site). The objective of this ASSMP was to detail management strategies to mitigate the risks posed by the identified acid sulfate soils (ASS) at the site associated with the Stage 3 development works.

The site has an approximate land area of 8,884 m^2 and is legally defined as Lot 111 in Deposited Plan (DP) 1265226, Lot 469 in DP 821073, and Lots 2-7 in DP 14761.

Refer to **Figure 1** for the site location provided in **Appendix A**.

2. BACKGROUND

2.1 Project Appreciation

A mixed commercial land use has been proposed for development at the site. The proposed development includes the construction of a basement carpark covering the entire area, and three multi-storey residential/commercial structures situated above the basement.

The development is proposed to be carried out in three stages.

- Stage 1 – The newly constructed Australian Taxation Office building in the north of the site;
- Stage 2 – The newly constructed residential building in the mid-east of the site; and
- Stage 3 – The remaining area of an irregular shape of 8,884 m^2 (to which this ASSMP applies).

ASS investigation which identified potential ASS (PASS) was conducted at the site as a component of the updated Detailed Site Investigation (DSI) of the site, conducted by EDP (EDP *Ref: S-02188.DSI.001*, dated October 2020) (EDP 2020). Details of the ASS investigation are provided in **Section 6**.

2.2 Proposed Excavation, Construction Methods and Estimated Volumes

It is anticipated excavation would be carried out using conventional excavation equipment. Review of the plans indicating the finished surface levels, taking into account the additional excavation required to construct the proposed development, is expected that excavation would be required from 1 m to 2 m depth for the proposed carpark and building. Given this information and the plan dimensions of the proposed carpark, it is anticipated that approximately 600 m^3 to 800 m^3 would be disturbed during its construction. With regard to the building footprint, it is expected that approximately 5,000 m^3 of soil would be disturbed during construction.

3. OBJECTIVES

This ASSMP was developed to assist in the effective management of the environmental risks associated with ASS during the proposed civil works to be undertaken at the site. The objectives of the ASSMP are to:

- Ensure field staff are aware and can identify ASS during the proposed works;
- Ensure appropriate control measures are adopted to protect the environment;
- Provide a framework to manage waste soils which are potentially acid sulfate generating during the proposed works; and
- Provide options for long-term management of ASS materials remaining in-situ.

4. TECHNICAL FRAMEWORK

This ASSMP has been developed in general accordance with the following documents:

- NSW *Work Health and Safety Act 2011*;
- NSW *Work Health and Safety Regulation 2017*;
- NSW EPA *Waste Classification Guidelines 2014: Part 1 – Classifying Waste; and Part 4 – Acid Sulfate Soils 2014* (NSW EPA 2014);
- NSW EPA *Protection of the Environment Operations (POEO) Act 1997*;
- NSW EPA *POEO (Waste) Regulation 2014*;
- NSW EPA *Contaminated Sites Sampling Design Guidelines 1995*; and
- ASSMAC *Acid Sulfate Soils Assessment Manual 1998* (ASSMAC Manual 1998);
- Queensland Government, *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2014;*
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000* (ANZECC 2000);
- NSW EPA *Environmental Guidelines: Assessing and Managing Acid Sulfate Soils 1995*;
- NSW EPA *Contaminated Land Guidelines, Guidelines for Consultants Reporting on Contaminated Land 2020;*
- NSW EPA *Guidelines for the Site Auditor Scheme, 3rd Edition 2017*;
- *National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 and Amendment 2013* (NEPM 2013);
- Australian Standard (AS) 4482.1, *Guide to Investigation and Sampling of Sites with Potentially Contaminated Soil, Part 1: Non-volatile and Semi-volatile Compounds 2005* (AS4482.1-2005);
- AS4482.2, *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 2: Volatile Substances 1999*.

The ASS assessment criteria as based on the ASSMAC Manual 1998 which incorporates the following guidelines:

- *ASSMAC Acid Sulfate Soil Assessment Guidelines 1998*;
- *ASSMAC Acid Sulfate Soil Planning Guidelines 1998;*
- *ASSMAC Acid Sulfate Soil Management Guidelines 1998;* and
- *ASSMAC Acid Sulfate Soil Laboratory Method Guidelines 1998.*

The ASS Manual 1998 provides advice on best practice in planning, assessment and management of activities in areas containing ASS. These guidelines update and expand on the NSW EPA Environmental Guidelines: Assessing and Managing Acid Sulfate Soils 1995.

5. SITE INFORMATION

5.1 Site Identification

Site identification details are summarised in **Table 1** and the location of the site is shown on **Figure 1** and site layout on **Figure 2**, provided in **Appendix A.**

Table 1: Site Identification

Site Identification	
Site Address:	26-30 Mann Street, Gosford NSW
Legal Identification:	Lot 111 in DP 1265226, Lot 469 in DP 821073, Lots 2-7 in DP 14761.
Local Government Area:	Central Coast Council
Investigation Area:	8,884 m^2
Current Zoning:	B4 – Mixed Use under the State Environmental Planning Policy (Gosford City Centre) 2018

Site Identification	
Former Land Use	The site was the former Gosford Public School until its demolition in 2014. More recently, the site has been used as a construction yard, temporary offices, car parking and storage for the adjoining Stage 1 and 2 developments.
Current Land Use:	Vacant land
Acid Sulfate Soils:	A review of ASS information contained within the online Australian Soil Resource Information System database indicated there was a high probability/high confidence of acid sulfate soils occurring beneath the site. Further review of Council's Acid Sulfate Soils Risk Map indicated that the site was situated within Class 2 Terrain. Class 2 terrain indicates that development consent is required where works are expected to occur below the natural ground surface, or by which the water table is likely to be lowered. Based on the intrusive investigation conducted, PASS is known to exist within the natural subsoil materials underlying the fill at the site.
Proximity to Local Sensitive Environments:	No surface water bodies were noted to be present at the site. The nearest offsite sensitive receptor appears to be Brisbane Water, approximately 150 m to the south-west of the site.

6. PREVIOUS ACID SULFATE SOIL ASSESSMENTS

6.1 Summary of Previous Acid Sulfate Soils Investigation

The most recent intrusive assessment incorporating ASS investigation at the site was undertaken by EDP in October 2020 (*EDP Updated DSI for 26-30 Mann Street, Gosford NSW:* EDP *Ref: S-02188.DSI.001*), dated October 2020 (EDP 2020).

In summary, a total of 25 sampling locations were investigated to target the fill and natural soil horizons to a maximum depth 5.0 m below ground level (mbgl). EDP 2020 sampling locations are shown on **Figure 2,** provided in **Appendix A** of this report.

Interpretation of the presence and extent of ASS based on EDP 2020 is summarised as follows:

- Actual ASS was not identified at the site during the assessment;
- PASS was identified within the natural soils starting at varying depth horizons, as shallow as 0.5 m to as deep as 1.5 m, underlying the fill material across the site; and
- The PASS impacted soil encountered during the EDP 2020 assessment predominantly consisted of dark brown/black fine-grained clayey sand and stiff grey clay with an organic odour.

6.2 Assessment Criteria

Assessment of ASS conditions and the impacts of the proposed development were based on information provided in the ASSMAC Guidelines 1998 presented in the ASSMAC Manual 1998. The ASSMAC Guidelines 1998 include information on assessment of the likelihood that the site lies within an ASS area, the need for an ASS management plan, and the development of mitigation methods for the proposed development.

The guidelines provide action criteria which determine the need to prepare an ASSMP, based on the percentage of oxidizable sulfur or Total Potential Acidity (TPA), for broad categories of soil. The action criteria adopted for the EDP 2020 investigation are provided in the **Table 2**.

Table 2: Action Criteria

Type of Material		Action Criteria 1–1000 tonnes ASS disturbed		Action Criteria if more than 1000 tonnes disturbed	
Texture range. McDonald et al. (1990)	**Approx. clay content (%<0.02mm)**	**Sulfur trail** *% S oxidisable (oven-dry basis) e.g. S_{TOS} or S_{POS}*	**Acid trail** *mol H^+/T (oven-dry basis) e.g. TPA or TSA*	**Sulfur trail** % S oxidisable (oven-dry basis) e.g. STOS or SPOS	**Acid trail** *mol H+/T (oven-dry basis) e.g. TPA or TSA*
Coarse Texture	<5	0.03	18	**0.03**	**18**
Sands to loamy sands	5 - 40	0.06	36	0.03	18
Medium Texture	>40	0.1	62	0.03	18

The action criteria for coarse textured soils (sands to loamy sands) and >1000 tonnes disturbed was adopted for the EDP 2020 assessment.

6.3 Summary of Analytical Results

6.3.1 *Acid Sulfate Screen Analysis*

A total of 36 selected soil samples were analysed for presence of ASS by way of an initial ASS field screen (in accordance with *ASSMAC Guidelines 1998* Section 2.2). A review of analytical results indicated the following:

- pH_f (pH prior to oxidation) ranged between 4.8 and 6.7;
- pH_{fox} (pH post oxidation) ranged between 2.6 and 6.7 (six samples recorded pH_{fox} less than 3); and
- The observed reaction of soil samples varied from low to extreme, indicating a varied risk of acid generation in oxidised at the site.

Based on the review of the acid sulfate screen analytical results, additional analysis was required to determine the risk of site soils being ASS, and determine an appropriate liming rate, should liming be required. Laboratory results are summarised and presented in **Appendix A**.

6.3.2 *Chromium Reducible Sulfur*

A total of 22 samples were selected for additional analysis (chromium reducible sulfur suite), to ascertain physiochemical properties of the subject soils that could be compared to the adopted action criteria. This allowed for the determining of the risk posed by the subject soils pertaining to sulfate derived acidity and total potential acidity, allowing informed decisions regarding the management soils at the site to be made.

Review of analytical results showed varying degree of total actual acidity and sulfidic acidity within samples assessed. Analysis identified soils with moderate potential acidity with generally mild oxidisable sulfur, indicating other acidity sourced (i.e. organic matter) were present within the subject soils. Laboratory results are summarised and presented in **Appendix A**.

6.4 Conclusive Statement

Based on the findings of the EDP 2020 site assessment and review of the analytical results, EDP found that potential acidity existed within underlying natural soils at the site that exceeded the adopted ASS criteria. Therefore a risk of acidic and acid generating soils was identified within some soils underlying the site, that must be treated as ASS. Based on EDP's understanding of the proposed development at the site, these soils were expected to be impacted by the proposed development. Therefore, a site specific ASSMP was deemed to be a requirement for the proposed Stage 3 development works, in order to detail the appropriate management strategies required to mitigate the infrastructural and environmental risks posed by the ASS at the site.

6.5 Historical Acid Sulfate Soil Investigation

A DSI undertaken by Coffey Environmental (Coffey) in 2019 (*Coffey Ref: SYDGE14942-AC_Rev4,* dated August 2019) (Coffey 2019) included analysis of selected soil samples for the presence of ASS. A review of Coffey 2019 ASS analytical results indicated the following:

- pH_f ranged between pH 5.5 and pH 10.
- pH_{fox} ranged between pH 2.9 and pH 8.4 (only one sample recorded pH_{fox} <3).

Eight selected soil samples were further analysed using the sPOCAS method. The laboratory results did not contain potential and actual acid sulfate soils given that Sulfur (KCl extractable) and Peroxide Oxidisable Sulfur were both detected below laboratory's limits of reporting.

Coffey 2019 concluded that based on the results, there is a relatively low likelihood of widespread presence of ASS in the alluvial material from the site.

7. ACID SULFATE SOIL DELINEATION AND MANAGEMENT STRATEGY OVERVIEW

7.1 Acid Sulfate Soil Occurrence

Based on the results of the EDP 2020 assessment it was considered that the following soils have an elevated risk of containing PASS and should be assumed to be PASS unless further investigation confirms otherwise:

- Dark brown/black fine-grained clayey sand; and
- Stiff grey clay.

PASS was identified within the natural soils from varying depths as shallow as 0.5 m to as deep as 1.5 m underlying the fill material across the site.

7.2 Management Strategy Overview

ASS management will be required to prevent adverse impacts occurring to the environment and infrastructure from ASS during the proposed excavation works at the site. As acidity is transported by water, excavation should be conducted during dry periods as far as possible as this will minimise the risk associated with water acidification during the works.

Based on the nature of the works, and the identification of PASS within the natural soils planned for disturbance, the recommended ASS management strategy for the proposed works should be undertaken over three stages:

- Stage 1: Onsite treatment prior to off-site disposal;
- Stage 2: Disposal of treated ASS offsite; and
- Stage 3: Onsite remediation for materials remaining in-situ.

8. RESPONSIBILITIES

A copy of this ASSMP should be kept onsite at all times and anyone who will conduct work within the site or will be undertaking future works must be inducted into this ASSMP.

Table 3 provides a summary of responsibilities of interested parties onsite which relates to the project.

Table 3: Summary of Responsibilities

Position/Organisation	Report to	Summary of Responsibilities
St Hilliers	Regulatory Authorities (as required)	Engage Civil Contractor. Engage a suitably qualified environmental consultant (eg. EDP) Provide funding for approvals. Communicate requirements to all contractors. Review documentation provided by contractors.

Position/Organisation	Report to	Summary of Responsibilities
		Review the ASSMP and any other reports developed by consultants. Ensure the ASSMP is implemented correctly. Ensure the ASSMP is available to anyone conducting excavation works onsite.
Civil Contractor	St Hilliers	Must have experience in managing, treating and disposing ASS. Complete SafeWork NSW permits and notification as required. Notify landfill for acceptance of the waste and adhere to landfill requirements. Undertake ASS treatment, soil and wastewater removal in accordance with their contract and ASSMP requirements for the site. Follow instructions by environmental consultant during the works. Regularly inspect and monitor all activities for adherence to appropriate environmental standards. Undertake works in a safe and environmentally responsible manner and in accordance with legislative requirements. Management of unexpected constraints and conditions that may arise during the works.
Environmental Consultant (eg. EDP)	St Hilliers	Must be experienced in contamination assessments including the identification and management of ASS. Provide work, health and safety and environmental consultancy to St Hilliers. Ensure works are undertaken in accordance with this ASSMP and current legislative requirements. Provide validation testing for ASS and waste classification assessments prior to off-site disposal as required. Track all materials moving on and off-site. Undertake surface water monitoring as required.

9. STAGE 1: ONSITE TREATMENT PRIOR TO OFF-SITE DISPOSAL

The strategy outlines the onsite neutralisation, management, monitoring and validation of ASS within soils planned for off-site disposal. This strategy should be undertaken as required using the methodology outlined below.

9.1 Site Setup

Responsible Party: Civil Contractor

An appropriate assessment/treatment area must be constructed for the treatment of excavated soils. The soils are to remain within this area until the treated soils are considered appropriate to be removed off-site. The assessment/treatment area should be constructed in accordance with the *ASSMAC Management Guidelines 1998* and the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2014*.

Allowances should be made during construction planning to resume sufficient land to allow for these items. **Figure 1** below shows a cross section of a typical treatment pad.

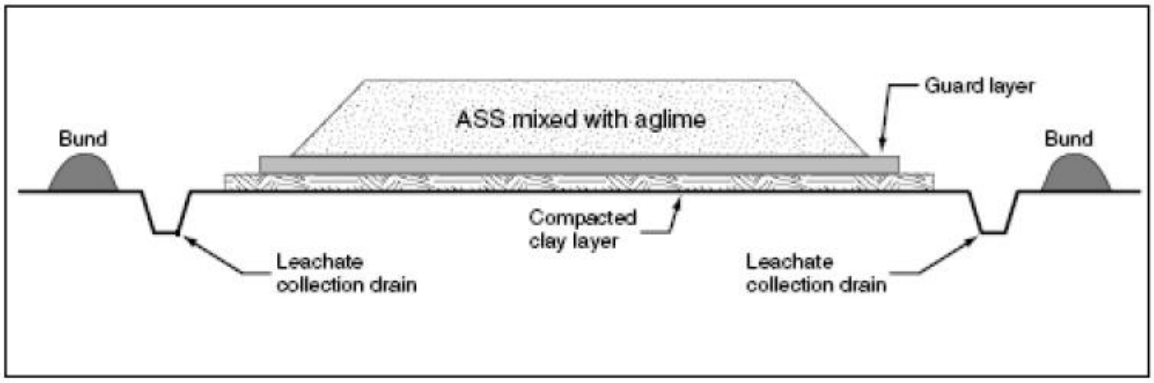

Figure 1: Schematic cross-section of a treatment pad, including clay layer, guard layer, leachate collection system and containment with bunding

The assessment/treatment area should be prepared as follows:

- Prepare a treatment pad of appropriate area for the volume of soil to be treated/stored. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues.
- It is recommended that the ASS assessment/treatment area must be constructed on hardstand or a similar impervious layer such as high-density polyethylene (HDPE) sheeting, and shall be within a portion of the site that does not lie in a natural drainage line.
- Apply a guard layer of fine agricultural lime (ag-lime) over the impervious layer, to neutralise downward seepage. This guard layer should be applied at a rate of 5 kg of ag-lime/m^2 per vertical meter of fill. The guard layer should be re-applied following removal of treated soils prior to addition of untreated ASS.
- Liming pads should be bunded with onsite soils not classified as PASS and a perimeter drain excavated to collect and contain leachate. The bunds should be preferably constructed of low permeability soil (i.e. clay) or, where suitable soil is not available, hay bales covered with impermeable plastic, with bunds at least 0.3 m high around the entire stockpile/treatment area. The drain and inner bund slopes should have a layer of ag-lime applied to neutralise any possible leachate migrating from the stockpiled material.

It should be noted that alternate methods for establishing an appropriate assessment/treatment area may be considered due to practicality constraints onsite. This would be subject to achieving the required treatment standard to the satisfaction of a suitably qualified environmental consultant.

9.2 Treatment Process

Responsible Party: Civil Contractor and Environmental Consultant

The treatment process should involve the following:

- Removal of non-ASS overburden from the soils containing ASS (i.e. remove the fill layer) to the satisfaction of a suitably qualified environmental consultant;
- Transport ASS material requiring treatment to the assessment/treatment area;
- Manage ASS during stockpiling and treatment to minimise dust and leachate generation (eg. by covering, or lightly conditioning with water). If wet weather prevails, stop works and cover the stockpiled material with a HDPE sheeting to reduce the formation of leachate;
- Limit the surface area of the ASS exposed to oxygen by forming relatively high-coned stockpiles;
- Material must be treated as soon as practical. Several treatment areas may be required for stockpiling and treatment, depending on the quantity of ASS material excavated;
- Spread the ASS onto the guard layer in a layer of 0.2 to 0.3 m thickness. When spreading the first soil layer, care should be taken not to churn the lime guard layer;
- Let the ASS dry to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be undertaken);
- Apply ag-lime (refer to **Section 9.3)** to the stockpiled soil, at the indicative liming rate in **Section 9.4** and harrow/ mix thoroughly prior to spreading the next layer;

- Continue the spreading/liming/mixing cycle. This can be done one layer at a time, or with multiple ASS layers placed on top of each other;
- Assess the success of the treatment using validation testing in accordance with **Section 9.5**;
- Samples will need to be collected from all layers, which is likely to require use of plant for sampling;
- If validation sampling indicates that additional neutralisation is required, add additional lime and mix;
- When validation testing indicates that lime neutralisation is complete in accordance with **Section 9.5.1**, then the stockpiled soil may be assessed for waste classification purposes;
- Undertake waste classification assessment and dispose off-site in accordance with **Section 10;**
- Management of leachate and wastewater in accordance with **Section 12**.

Given that excavation of acidic and ASS will be required for the proposed development, the excavated soils should be stockpiled such that the acidic soils are segregated from the ASS and that these soils are also segregated from the non-ASS.

Additionally, stockpiles of ASS should be kept moist to minimise oxidation, prior to lime treatment. They should be covered to prevent rainfall leaching through the stockpile and possibly creating acidic runoff and be located as far away as possible from any sensitive receptors (e.g. waterways, drainage channels etc.)

9.3 Neutralising Materials for Soils

Responsible Party: Civil Contractor and St Hilliers

An appropriate neutralising agent must be selected for the works. Ag-lime is the preferred neutralisation material for the management of ASS. Ag-lime comprises calcium carbonate ($CaCO_3$), typically made from limestone that has been finely ground and sieved to a fine powder. Ag-lime with a purity of 95% or better should be used (i.e. ENV $\geq$95, where ENV is the effective neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine $CaCO_3$ which is designated ENV = 100). The ag-lime should be fine and dry, as texture and moisture can also decrease the ENV.

9.4 Lime Application Rate

Responsible Party: Civil Contractor and Environmental Consultant

The amount of lime required for treatment of ASS material must be estimated based on the laboratory analytical results detailed in EDP 2020 ASS assessment.

Based on the results of the Chromium Reducible Sulfur suite, a liming rate was calculated (kg of $CaCO_3$/tonne of soil), detailing the volume of lime required to neutralise the acidity present within the soils, based on total and potential acidity as well as the acid neutralising capacity of the soils. For the 22 samples subject to this suite of analysis, the liming rate varied from <0.75 kg/tonne to 6.5 kg/tonne.

EDP 2020 identified varied amounts of actual and potential acidity within soils at the site, leading to varied calculated liming rates, depending on sampling location. Given the range of results, it is considered that there a high risk that excavated natural soils will be potential or actual ASS. As such, all excavated natural soils must be subject to liming.

Using the most conservative analytical results of EDP 2020 and assuming the use of 95% ENV ag-lime value of 0.05% oxidisable sulfur for soils between horizon depths starting from 0.5 down to 1.5 mbgl. The estimations were made with reference to Tables 4.5 and 4.6 in the ASSMAC Management Guidelines 1998.

Based on the above, the liming rate recommendation is:

- **10 kg of ag-lime per tonne of soil excavated.**

It should be noted that the acid production will vary both horizontally and vertically through the ASS profile due to the variability of natural systems. The liming rate to be calculated from the analytical results should therefore be considered as a 'starting point', and pH monitoring should be conducted during treatment to assess the progress of the neutralisation, and need for additional mixing and/or addition of ag-lime.

Material will only be considered to have been successfully treated when all soil has been validated in accordance with **Section 9.5.1.** If an alternate neutralising product is used, a specific dosing rate will need to be calculated.

A useful online liming rate calculator provided by the Western Australian Government, Department of Environment Regulation can be used for updating liming rates if more analytical data becomes available during the works.

Liming Rate Calculator: https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate calculations-for-neutralising-acid-sulfate-soils

For material remaining in-situ, an application of lime should be applied by dusting the top surface of the soil following excavation. The intent is to form a narrow crust of neutralised soil to prevent significant acid generation. However excessive amounts of lime should not be applied to prevent altering the chemistry of the receiving waterbody. It should be noted that in-situ material does not require validation, however ongoing monitoring may be required for soil and water parameters at the site.

9.5 Validation Testing

Responsible Party: Civil Contractor and Environmental Consultant

A suitably qualified environmental consultant must conduct all validation inspections and validation sampling required during the treatment works. The validation assessment should be conducted progressively throughout the bulk excavation works, following the neutralisation and blending of each stockpile of material. The validation assessment shall be undertaken as follows:

- During and following neutralisation, the stockpiled soils will require pH screening to confirm that the appropriate quantities of lime have been added and the soils have been suitably mixed/blended:
- The pH testing should be undertaken on the treated material at the following frequency:
  - 1:25 m^3 of treated soil or a minimum of four samples per treatment batch.
  - pH to be measured using 1:5 soil:water (pH_f) and field oxidised 1:4:1 soil:water:peroxide (pH_{fox}).
- NATA accredited laboratory testing using appropriate laboratory methods including sPOCAS or Chromium Reducible Sulfur suite should also be undertaken at a frequency of at least 1:250 m^3 from within the treated material, as outlined below, to validate the lime neutralisation:
  - Validation sampling locations to be selected on:
    - Systematic sampling (gridded) pattern;
    - Visual inspection for indications of ASS during site inspection; and
    - Accessibility of the proposed sampling location.
  - Validation samples shall be collected using the following methodology:
    - Soil samples will be recovered from a minimum of 0.3 m beneath the soil surface of the stockpile utilising hand equipment;
    - Nitrile gloves will be used during sampling, with a change of gloves between each sampling location;
    - Soil samples will be collected in sampling containers provided by the analysing laboratory, ensuring sufficient sample is collected for the required analysis;
    - All containers will be clearly labelled with unique sample identification; and
    - All samples will be stored on ice prior to dispatch and during transportation to the nominated laboratory under chain of custody procedures.
- Compare the validation results with the acceptance criteria given in **Section 9.5.1**. If all results meet the acceptance criteria, the ASS will be considered to have been successfully treated and may be disposed off-site to an appropriately licensed waste facility following the procedures outlined in **Section 10**.
- Analytical results are to be compiled into a ASS stockpile validation report and incorporated into this ASSMP.

9.5.1 Acceptance Criteria for Treated Acid Sulfate Soils

The acceptance criteria are based on the results of field pH screening and sPOCAS or Chromium Reducible Sulfur testing. Appropriate neutralisation will have been considered where:

- Field pH (pH_f) = 6.0-8.5;

- Oxidised pH (pH_{fox}) = >5; and
- sPOCAS or Chromium Reducible Sulfur suite = Analytical results of the treated material must demonstrate compliance with adopted validation criteria through proving that the acid neutralising capacity (ANC_E) is greater than peroxide oxidisable sulfur (S_{POS}) and that no additional liming is required.

Further treatment of the soil will be required if any of the above conditions are not met. Once successfully treated, further assessment will be required to facilitate off-site disposal as detailed in **Section10.**

10. STAGE 2: OFFSITE DISPOSAL OF TREATED ACID SULFATE SOILS

Responsible Party: Civil Contractor and Environmental Consultant

Following successful treatment of ASS, the environmental consultant must undertake chemical assessment of the soils, or alternatively review the available chemical data for the soils for comparison against NSW EPA 2014 criteria in order to facilitate off-site disposal, if required.

Stockpiled materials will need appropriate storage onsite to await for the waste classification to be undertaken. As a minimum, each stockpile will need to be maintained and secured within the assessment/treatment area and covered with weighted HDPE sheeting to prevent leachate generation whilst awaiting waste classification assessment results.

Prior arrangements should be made with the waste facility to ensure that it is licensed to accept the waste. The waste facility should be informed that the PASS has been treated in accordance with the neutralising techniques outlined in this ASSMP produced in accordance with ASSMAC Manual 1998 and that the waste has also been classified in accordance with NSW EPA 2014.

11. STAGE 3: ONSITE REMEDIATION OF SOILS

Responsible Party: Civil Contractor and St Hilliers

Following excavation across the site, remaining soils exposed within the site will require long-term ASS management. This will include, but not be limited to, onsite remediation of the soils through the possible incorporation of neutralising agents to the surface layers application of organic matter and planting acid tolerant species.

The techniques provided in the *ASSMAC Management Guidelines 1998* have been adapted for the site as follows:

- Apply ag-lime into the surface layers of the soils (nominal depth of 0.1 m) at an application rate of 1 kg /m^2 following excavation to form a narrow crust of neutralised soil to prevent significant acid generation. Note that excessive amounts of lime should not be applied to prevent altering the chemistry of the receiving environment. This should be undertaken during dry periods as far as possible to maximise the neutralisation process.
- Organic matter content should be increased by incorporating composted green waste or other composted materials into the surface of the soils.
- Encourage the growth of water and acid tolerant species that will assist in building up an organic peat layer across the site.
- Develop an ongoing monitoring program to track changes in soil and water within the receiving environment.

Important Note: Neutralising agents are an essential component of most ASS management proposals and the impacts of using these products in naturally soft acidic freshwater habitats are not adequately understood. What is known is that neutralising agents can alter naturally low pH environments that have organic-sourced acidity and can increase water hardness, causing changes to habitat that ultimately result in species, population and ecological system shifts.

12. WATER MANAGEMENT

12.1 Leachate and Wastewater Management

Responsible Party: Civil Contractor

Given the presence a shallow groundwater table and the likelihood of the acidic and ASS being saturated during excavation, it is expected that dewatering will be required and that leachate will be generated form the stockpiled soils. Given the presence of acidic and ASS, it is possible that the leachate / groundwater may have an adverse impact on the environment, if untreated. Any leachate / groundwater generated should be collected for subsequent monitoring and treatment as required. The following is recommended:

- Eliminate need for dewatering, where possible.
- Minimise the time and volume of dewatering (i.e. staged dewatering and excavation over relatively short durations), if undertaken.

The pH of leachate water or water extracted during dewatering operations should be monitored and adjusted prior to discharge. Adjustment of pH should be undertaken if discharge water falls outside the discharge quality limits specified for discharge to the sewerage or stormwater system (subject to regulatory approval) or the land via evaporation/infiltration. The pH levels should also be compared to background levels of nearby waters.

The amount of neutraliser required to be added to the discharged leachate/groundwater can be calculated from the equation below:

$$\text{Alkali Material Required (kg)} = [(M_{Alkali} \times 10^{-pH}\ \text{initial}) / 2 \times 10^{3}] \times V$$

Where: pH initial = initial pH of leachate

V = volume of leachate (litres)

$M_{Alkal\ i}$ = molecular weight of alkali material (g/mole)

The alkali should be added to the discharged leachate/groundwater water as slurry. Mixing of the slurry is best achieved using an agitator. Leachate water collected from bunded areas and stockpiles (in catch ponds), and extracted groundwater should be neutralised as necessary before release. Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over neutralisation to occur. Furthermore, whilst ag-lime is well suited to the treatment of soils, it does not dissolve well in water, hence it is not very effective at adjusting the pH of water. Hydrated lime ($Ca(OH)_2$) is more soluble than ag-lime making it more suited to treating water, but it has a high pH value (pH ~12). Therefore, if hydrated lime is to be used to treat water, then it should be added incrementally with care and thoroughly mixed to prevent overshooting the desired pH. As a guide, the approximate quantities of hydrated lime provided in **Table 4**, would be required to neutralise acidic water.

Table 4: Recommended Approximate Liming Rates for Water

Water pH	Water Extraction Rate		
	2 m^3/hr	5 m^3/hr	10 m^3/hr
2	0.74	1.85	3.7
3	0.074	0.185	0.37
4	0.0074	0.0185	0.037
5	0.00074	0.00185	0.0037
6	0.000074	0.000185	0.00037

Notes: Liming rates are for hydrated lime (kg of $Ca(OH)_2$)

12.1.1 Water Discharge Criteria

Notwithstanding any additional regulatory requirements placed on water disposal by Central Coast Council, it is recommended that Council's Policy for the Discharge of Liquid Trade Waste and Septic Waste to the Council's Sewerage System and the ANZECC 2000 criteria are met before discharging any water, leachate or groundwater to the environment, as detailed in **Table 5**.

Table 5: Water Discharge Criteria

Indicator	Sewer	Stormwater	Land Application
pH	7.0 – 9.0	6.0 – 8.0	6.0 – 8.0 (or within background levels)
Total suspended solids (TSS)	300 mg/kg (600 mg/L)[2]	25 mg/L	NA
Visible oil & grease	NA	None visible	None visible
Total dissolved solids (mg/L)	1,000	10,000	1,000

Notes:
1. Field measurement of turbidity may be substituted for TSS subject to regulatory approval. Correlation of Turbidity to TSS is dependent on site specific factors and it is recommended that if turbidity is to be monitored then the relationship should be establish at the commencement of the monitoring programme. Notwithstanding, an initial approximate correlation of turbidity to TSS would be 0.5 NTU approximates 1 mg/L TSS.
2. It is understood that concentration up to 600 mg/L may be accepted by GCC for some sites.

13. REPORTING

ASSMAC Manual 1998 does not require formal reporting of ASS management however, it is important to keep records of the management and validation process to show compliance with the guidelines.

A record of management, treatment, monitoring, validation and disposal of ASS should be maintained by the Civil Contractor and provided to St Hilliers and should include the following details:

- Date(s) of works involving ASS;
- Location/area and depth of excavated ASS;
- Waste facility location and copy of licence;
- Where relevant for neutralisation of ASS, an ASS stockpile validation report should be prepared which includes:
  - Neutralisation process undertaken;
  - Liming rate utilised;
  - Results of field and analytical testing and comparison to acceptance criteria;
  - Neutralised ASS disposal (landfill) location; and
- Tonnages of material treated/disposed and waste dockets.

14. CONSULTATION AND COMMUNICATION

All project personnel, subcontractors and consultants will receive training in both St Hilliers and their personal environmental obligations during the inductions and toolbox talks.

All project personnel will undergo a general project induction prior to commencing work with St Hilliers. This will include an ASS component to reinforce the importance of management and the measures that will be implemented to address ASS issues at the site.

Site inductions and toolbox talks will highlight the specific environmental requirements and activities being undertaken at the site. These will be based on the measures outlined in the specific Safe Work Method Statements. Examples of topics that should be covered during project induction and toolbox talks include:

- Location and planned disturbance of ASS at the site;

- Management procedures in place for handling and treating ASS impacted soils;
- Site set up and location of ASS treatment areas; and
- Unexpected discovery of ASS.

15. ENVIRONMENTAL INCIDENT & COMPLAINTS MANAGEMENT

Details of all complaints received or incidents must be recorded on the Complaint/Incident Record Form provided in the site Environmental Management Plan, with the information to be recorded to include, as a minimum:

- Date and time that the complaint was received, or the incident occurred;
- The name, address and contact details of the person making the complaint, or reporting the incident;
- The name of the person who received the complaint, or received notification of the incident;
- A brief description of the issue; and
- A summary of the actions implemented to address the complaint/incident, including the dates that these actions were implemented and the signature of the persons responsible for resolving or rectifying the issue.

16. SITE SUPERVISION

Site supervision during excavation/earthworks by appropriately qualified environmental consultant is required to ensure that the excavated materials are appropriately handled and that materials different to those encountered during the investigation onsite are assessed, if encountered. It is envisaged that written instruction would be issued to the site personnel at the completion of each inspection that would identify the materials encountered during excavation and the appropriate treatment or handling procedures required.

As part of the site supervision the environmental consultant shall be responsible for monitoring excavations, field and laboratory assessments, truck loading and recording the truck movements and load characteristics. Load information shall be verified by comparison with tip dockets. The environmental consultant shall also maintain a daily record containing the following information:

- Details of unusual materials or odours encountered during excavations;
- pH meter calibration details;
- Location and results of pH monitoring;
- Details of accidents or incidents on the site;
- Details of any environmental issues and any related corrective and preventive action taken;
- Details of any visitors relation to environmental or health issues;
- Details of contractors engaged for the removal of waste;
- Record of soil volumes excavated, truck movements including destination/source, volumes of material exported/imported to the site;
- Daily site diagrams showing the location of stockpiles, excavations and sediment controls; and
- Records of soil sampling locations.

17. DOCUMENTATION AND RECORD KEEPING

All relevant documentation will be maintained by St Hilliers. The documentation to be maintained may include (but not be limited to):

- Staff and contractor inductions provided as **Appendix E** of this ASSMP;
- NSW EPA Waste Transport Certificates;
- Transportation dockets for excavated soil removed from the site, with a summary of these to be included on the materials tracking forms provided as **Appendix F** of this ASSMP;

- Soil classification documentation that relates to any soil that requires further investigation and sampling during the course of the excavation works;
- Ongoing management requirements for material to remain in-situ;
- Stockpile validation and classification records; and
- Complaints/incidents register.

Appendix A: Figures and Summary Data

26-30 Mann Street, Gosford NSW

ASSMP

Site Location

LEGEND:

⊕	Site location
▭	Approximate site boundary

Image from: Nearmap, 2020

DETAILS:

Client Name:	SH Gosford Residential Pty Ltd
EDP Reference:	S-02118.001 V3 / S0001
Figure Number:	1
Figure Name:	Site Location
Assessment Date:	Friday, 2 October 2020

edp

26-30 Mann Street, Gosford NSW

Updated Detailed Site Investigation

Sampling Plan

LEGEND:	
	Approximate site boundary
⊗	Approximate test pit location
⊗	Approximate borehole location

Image from: Nearmap, 2020

DETAILS:	
Client Name:	SH Gosford Residential Pty Ltd
EDP Reference:	S-02118.001 V3 / S0001
Figure Number:	2
Figure Name:	Sampling Plan
Assessment Date:	Friday, 2 October 2020

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils								
			Field Screen			Chromium Reducible Sulfure					
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-TP03_1.2	1/10/2020	1.2	6	4.9	Low reaction	5.8	<5	<0.01	<0.005	<0.75	<0.75
S-02188.001-TP04_1.2	1/10/2020	1.2	4.9	3.1	Medium reaction	4.5	11	0.02	<0.005	1	1
S-02188.001-TP05_1.4	1/10/2020	1.4	6	3.8	Extreme reaction	5.6	6	<0.01	0.009	0.8	0.82
S-02188.001-BH01_2.0	1/10/2020	2	4.8	4.4	High reaction	4.1	34	0.06	<0.005	3	2.9
S-02188.001-BH01_3.0	1/10/2020	3	5.3	3.4	High reaction	4.1	34	0.05	0.005	3	3
S-02188.001-BH01_4.0	1/10/2020	4	5.4	3.7	Medium reaction	4.5	14	0.02	<0.005	1	1.1
S-02188.001-BH01_5.0	1/10/2020	5	5.7	4.7	Low reaction	4.8	<5	<0.01	<0.005	<0.75	<0.75
S-02188.001-TP06_1.0	1/10/2020	1	4.7	3.5	Volcanic reaction	4	49	0.08	0.005	4	4.3
S-02188.001-TP07_1.3	1/10/2020	1.3	6	3.4	Extreme reaction	-	-	-	-	-	-

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils								
			Field Screen			Chromium Reducible Sulfure					
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-BH05_2.0	1/10/2020	2	6.1	4.5	High reaction	5.8	<5	<0.01	<0.005	<0.75	<0.75
S-02188.001-BH05_3.0	1/10/2020	3	6.6	5.5	Medium reaction	5.8	<5	<0.01	<0.005	<0.75	<0.75
S-02188.001-BH05_4.0	1/10/2020	4	6	5.1	Medium reaction	5.2	<5	<0.01	<0.005	<0.75	<0.75
S-02188.001-BH05_5.0	1/10/2020	5	6.3	5.7	Low reaction	6	<5	<0.01	<0.005	<0.75	<0.75

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils									
			Field Screen			Chromium Reducible Sulfure						
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-TP08_1.2	1/10/2020	1.2	6.2	2.9	Extreme reaction	-	-	-	-	-	-
S-02188.001-TP09_1.5	1/10/2020	1.5	-	-	-	8.3	<5	<0.01	0.005	<0.75	<0.75
S-02188.001-TP10_1.0	1/10/2020	1	6.3	2.6	Volcanic reaction	4.8	17	0.03	0.02	2	2.1
S-02188.001-TP11_1.2	1/10/2020	1.2	6	3.3	Extreme reaction	-	-	-	-	-	-
S-02188.001-TP12_1.3	1/10/2020	1.3	5.8	3.5	Extreme reaction	-	-	-	-	-	-
S-02188.001-TP13_1.3	1/10/2020	1.3	6	3.9	Volcanic reaction	-	-	-	-	-	-
S-02188.001-BH02_2.0	1/10/2020	2	6.4	3.7	Low reaction	-	-	-	-	-	-
S-02188.001-BH02_3.0	1/10/2020	3	6.7	5.5	Medium reaction	-	-	-	-	-	-
S-02188.001-BH02_4.0	1/10/2020	4	6.1	5.4	Low reaction	-	-	-	-	-	-

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils									
			Field Screen			Chromium Reducible Sulfure						
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-BH02_5.0	1/10/2020	5	6.2	5.3	Medium reaction	-	-	-	-	-	-
S-02188.001-TP14_1.2	1/10/2020	1.2	6.3	4	Extreme reaction	-	-	-	-	-	-
S-02188.001-TP15_1.4	1/10/2020	1.4	6	2.8	Volcanic reaction	4.7	20	0.03	0.03	3	2.8
S-02188.001-BH03_2.0	1/10/2020	2	6.2	2.6	High reaction	4.3	18	0.03	0.01	2	1.9
S-02188.001-BH03_3.0	1/10/2020	3	6	3.8	Medium reaction	4	42	0.07	0.006	4	3.6
S-02188.001-BH03_4.0	1/10/2020	4	5.3	4.2	High reaction	4.1	39	0.06	0.009	4	3.7
S-02188.001-BH03_5.0	1/10/2020	5	5.5	4.1	Medium reaction	4.1	46	0.08	0.005	4	4.2
S-02188.001-TP16_1.2	1/10/2020	1.2	4.5	4	Extreme reaction	3.9	80	0.13	<0.005	6	6.5
S-02188.001-BH04_2.0	1/10/2020	2	5.1	2.9	High reaction	-	-	-	-	-	-

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils									
			Field Screen			Chromium Reducible Sulfure						
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-BH04_3.0	1/10/2020	3	5.5	3.5	Low reaction	-	-	-	-	-	-
S-02188.001-BH04_4.0	1/10/2020	4	5.8	5.3	High reaction	4.7	12	0.02	<0.005	1	1.1
S-02188.001-BH04_5.0	1/10/2020	5	6.2	6.7	Medium reaction	-	-	-	-	-	-
S-02188.001-TP17_1.1	1/10/2020	1.1	5	3.9	Volcanic reaction	-	-	-	-	-	-

SUMMARY OF ACID SULFATE SOIL RESULTS

edp
an RSK company

Analyte			Acid Sulfate Soils								
			Field Screen			Chromium Reducible Sulfure					
			pHF (field pH test)*	pHFOX (field peroxide test)*	Reaction Rate*	pH kcl	TAA pH 6.5 moles H+/t	s-TAA pH 6.5 %w/w S	Chromium Reducible Sulfur %w/w	Liming rate kg CaCO3/t	Liming rate without ANCE kg CaCO3/t
Practical Quantitation Limit (PQL)							5	0.01	0.005	0.75	0.75
Sample ID	**Date Sampled**	**Depth (m)**									
S-02188.001-TP18_1.0	1/10/2020	1	6.3	3.8	Extreme reaction	4.3	39	0.06	0.01	4	3.9
S-02188.001-TP20_1.5	1/10/2020	1.5	6.1	2.8	Medium reaction	-	-	-	-	-	-
Statistics		Minimum	4.5	2.6		3.9	6	0.02	0.005	0.8	0.82
		Maximum	6.7	6.7		8.3	80	0.13	0.03	6	6.5
		Mean	5.81	4.06		4.88	30.73	0.05	0.01	2.85	2.86
		Standard Deviation	1.10	1.19		2.55	19.58	0.03	0.01	1.71	1.73
		CoV	4.5	2.6		3.9	6	0.02	0.005	0.8	0.82

Appendix B: Acid Sulfate Soil Definitions and Potential Impacts

ACID SULFATE SOILS DEFINITIONS

ASS are naturally occurring sediments containing iron sulfides, primarily pyrite, commonly deposited in alluvial and estuarine environments. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to the coastal systems, these sediments are often overlain by terrestrial sediments.

When ASS are exposed to air (e.g. due to excavation or dewatering), the oxygen reacts with iron sulfides in the sediment, producing sulfuric acid. This acid can be produced in large quantities and is highly mobile in water. The process can also release iron and other metals present in the soils.

The sulfuric acid (and metals) can drain into waterways causing severe short and long-term socioeconomic and environmental impacts, including damage to man-made structures and natural ecosystems.

ASS can either be classified as AASS that have already reacted with oxygen to produce acid, or PASS. AASS and PASS are often found in the same profile, with AASS generally overlying PASS horizons.

PASS are soils containing iron sulfide that have not been exposed to oxygen (e.g. soils below the water table). The field pH of these soils in the undisturbed state is 4 or more and is commonly neutral or slightly alkaline. However, they pose a considerable environmental risk when disturbed, as they will become more acidic when exposed to air and oxidised.

POTENTIAL IMPACTS OF ACID SULFATE SOILS DISTURBANCE

The generation of AASS can result in the release of sulfuric acid and iron into the soil and surrounding waters. This in turn can release aluminium, nutrients and heavy metals (particularly arsenic) stored within the soil matrix. Once mobilised in this way, the acid, metals and nutrients can seep into waterways, killing fish, other aquatic organisms and vegetation.

Additionally, low levels of impact include reduced hatching, decline in growth rates, skin and health impacts for aquatic life. The potential impact on water leaching activities also include change in pH of soil and water, changes to water quality and changes to the hydraulic regime. Soil texture or sediment particle size distribution also affects the potential impacts of exposing ASS. Coarse-textured sulfidic sands are particularly vulnerable to rapid oxidation due to their relatively higher permeability and negligible buffering capacity. Water also moves through coarse material quickly, which may create large volumes of contaminated leachate.

AASS exposure can result in medium to long-term changes in soil chemistry. Changes in soil chemistry may affect the water quality of the tidally influenced area, resulting in reduced biodiversity and potentially death of flora and vegetation.

As the works will involve the disturbance of PASS adjacent to Brisbane Waters, the implementation of the controls detailed in this plan are required to minimise the potential acid generating impacts of the soils associated with the planned works at the site. Particular care should be taken with allowing air to penetrate sandy sediments as they have little buffering capacity. These materials can oxidise and leach very rapidly.

ACID SULFATE SOILS MAPPING

The Department of Land and Water Conservation has prepared Acid Sulfate Soil Risk Maps for the coastal areas in NSW that predicts the distribution of acid sulfate soils based on an understanding of the factors that led to their formation reinforced by extensive soil surveying. The Acid Sulfate Soil Risk Maps have also been converted into Acid Sulfate Soil Planning Maps for use with Local Environmental Plans.

The Acid Sulfate Soil Planning Maps establish five classes of land based on the probability of acid sulfate soils occurrence and the type of works that might disturb them. The five classes in the Acid Sulfate Soils Planning Maps are shown in the table below.

Acid Sulfate Soil Risk Classes

Class of land pertaining to ASS	Nature of works requiring ASS Assessment
1	▪ Any works
2	▪ Works below natural ground surface ▪ Works by which the water table is likely to be lowered
3	▪ Works beyond 1 m below natural ground surface ▪ Works by which the water table is likely to be lowered beyond 1 meter below natural ground surface
4	▪ Works beyond 2 meters below natural ground surface ▪ Works by which the water table is likely to be lowered beyond 2 meters below natural ground surface
5	▪ Works within 500 meters of adjacent Class 1, 2, 3 or 4 land which are likely to lower the water table below 1 m AHD on adjacent Class 1, 2, 3 or 4 land

Review of Central Coast Council's Acid Sulfate Soils Risk Map indicated that the site exists within Class 2 land. The presence of the site on Class 2 land indicates ASS are likely to be found below the natural ground surface and that development consent is required where works are expected to occur below the natural ground surface, or by which the water table is likely to be lowered.

Appendix C: Contingency and Emergency Response Procedures

CONTINGENCY AND EMERGENCY RESPONSE PROCEDURES

In the event of a non-conformance, the source and nature of the event should be investigated, the effectiveness of the existing controls reviewed and modified where practical, and necessary strategies implemented to minimise further impacts. Contingency strategies for stockpiles and water quality exceeding performance criteria are outlined in the table below.

Contingency strategies for stockpile treatment and water quality exceeding performance criteria

Item	Event	Contingency Measures
Stockpile Treatment	ENV is not provided with the neutralising material.	1:250 m^3 of lime applied should be sampled and analysed for calcium carbonate equivalence by a NATA accredited laboratory to determine the ENV of the material.
	Stockpile validation acceptance criteria are exceeded.	If pH_f and pH_{fox} results of treated soil validation samples are outside the acceptable thresholds, further lime treatment of soils should be undertaken.
	Soils encountered during excavation works are not representative of the soils previously identified.	The soils should be treated as containing sulfidic components and assumed to be ASS unless sampling and analysis confirms otherwise.
Water Quality	Performance criteria for pH are exceeded.	Cease works and assess control measures.
	EC, floatable matter and colours in the receiving water exceed performance criteria.	Cease works and assess control measures. A suitable treatment method such as aeration and/or filtration should be employed.

Appendix D: Unexpected Finds Protocol

IDENTIFICATION AND MANAGEMENT OF UNEXPECTED CHEMICAL CONTAMINATION AND/OR ACID SULFATE SOILS

ACID SULFATE SOILS

Should unexpected ASS be uncovered during the excavation works (i.e. the identification of soil displaying characteristics of the identified ASS geological units), the following steps should be followed:

- Cease works in the vicinity of the uncovered ASS;
- The workers identifying the unexpected ASS shall inform St Hilliers of the suspected ASS;
- Appropriately stockpile the soil within an area designated for ASS;
- If necessary, use physical barriers to shelter and prevent runoff to environmentally sensitive features (i.e. Parramatta River, vegetated areas etc.);
- Assume the soil is ASS until an assessment is conducted;
- Engage a suitably qualified environmental consultant to undertake an environmental assessment of the affected area and provide further advice; and
- Further remedial works may be required or additional control measures in order to maintain a safe work zone.

CHEMICAL CONTAMINATION

Unexpected chemical contamination or ASS may potentially be uncovered during excavation works.

Should unexpected chemical contamination be suspected during the excavation works (i.e. the identification of odorous or stained soil) the following steps should be followed:

- Cease works in the vicinity of the uncovered contamination;
- Inform the site foreman of the suspected contamination;
- Use a physical barrier to isolate the area;
- Assume the soil is contaminated until an assessment is conducted;
- Commission a suitably qualified environmental consultant to undertake an assessment to determine the next stage of works; and
- Further remedial works may be required or additional control measures in order to maintain a safe work zone.

Appendix E: Induction Records

ACID SULFATE SOIL MANAGEMENT PLAN INDUCTION RECORD

Name	Company	Date	Signature	Inducted by

Appendix F: Materials Tracking Record

ACID SULFATE SOIL MATERIALS TRACKING RECORD

Site:			Site Supervisor:		Logged by:	
Date	Volume of Material Removed (m3)	Liming Dose (kg/t)	Location Description (location and extent)	Material Description	Off-site Disposal Classification	Comments

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